Parasites of the Potato Tuberworm, Tomato Pinworm, and Other, Closely Related Gelechiids

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ABSTRACT

Parasites reared from the potato tuberworm, tomato pinworm, and other closely related gelechiids in the Americas are presented. The parasite complex associated with each gelechiid and the area of origin of the potato tuberworm and tomato pinworm are discussed briefly.

The potato tuberworm, *Phthorimaea operculella* (Zeller), is a worldwide pest of potato, tomato, eggplant, tobacco, and other Solanaceae. It is especially serious in dry, subtropical climates and during dry seasons in areas normally having adequate rainfall (Lloyd, 1972). The potato tuberworm occurs in all major potato-growing areas of central and southern California, but not in the extreme northern part of the state (Bacon, 1960). In southern California, where two irrigated crops of potatoes are grown annually, the pest is active throughout the year (Oatman & Platner, 1974).

The cultivated potato, *Solanum tuberosum* L., is the most common host of the potato tuberworm. The pest larvae mine the foliage, stems, and tubers. Most of the economic damage is to the exposed tubers prior to harvest; up to 100% may be infested if preventive measures, such as deep planting and ridging, are not used (Shelton & Wyman, 1979).

In the United States, the tomato pinworm, *Keiferia lycopersicella* (Walsingham), is a serious economic pest of fresh market tomatoes in California (Oatman, 1970), Florida (Wolfenbarger & Poe, 1973), and Texas (Harding, 1971). Based on personal observations by the senior author, it also is a serious pest of tomatoes in Hawaii and commonly infests commercial eggplant in southern California.

Because of the economic importance of potatoes and tomatoes in California's agricultural economy and the severity of the potato tuberworm and tomato pinworm to these crops, studies were initiated in 1963 in southern California to determine the parasite complexes associated with both pests on their respective host plants (Oatman, 1970; Oatman & Platner, 1974; Oatman et al., 1979). During the course of these studies, foreign exploration trips were made to potato- and tomato-growing regions of Mexico, Central, and South America by the senior author to attempt to delineate the area of origin of the potato tuberworm and tomato pinworm and to collect

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exotic parasites of each for release in southern California. Two such trips were made to Mexico (February, 1967 and 1981), two to Costa Rica (February, 1967, and April, 1973), and one each to Colombia (May, 1973) and Guatemala (February, 1977). Additionally, trips were made to Hawaii (June-December, 1977) and the Lower Rio Grande Valley, Texas (June, 1979) to collect parasites of the tomato pinworm. In all cases, parasitized material was collected from unsprayed plants, usually growing individually or in small plots, and shipped by air to the Division of Biological Control, University of California, Riverside, where the material was processed through the Division's quarantine facility. Parasites thus collected are shown in Tables 1 and 2. Included in Table 2 are parasites of the tomato pinworm collected in 1977 by Mr. Robert Burkhart, Division of Plant Industry, Department of Agriculture, State of Hawaii, during a foreign exploration trip to Arizona, California, Texas, Mexico, Guatemala, Honduras, and El Salvador.

From 1963 through 1965, the Department of Biological Control, University of California, Riverside, cooperated with the Commonwealth Institute of Biological Control (CIBC) by handling shipments of parasites of the potato tuberworm through the Department's quarantine facility. CIBC field agents collected parasitized material from potato foliage during the summers of 1962-63 and 1963-64 in Argentina and Uruguay and during the summer of 1964-65 in Peru (Lloyd, 1972). Parasites received from these shipments, plus five additional ones from CIBC facilities in South Africa and India, are listed in Table 1. Except for *Microplitis minutalis* Muesebeck, *Rhetisympiesis phthorimaeae* Blanchard and two species of *Apanteles* from Peru, sufficient numbers of each parasite species were obtained to establish insectary cultures. All the cultured species were released against the potato tuberworm in southern California (Oatman & Platner, 1974). Concurrently, cultures of the South American parasites were shipped to the Indian Station, CIBC, Bangalore, India, for propagation and distribution to other Commonwealth countries participating in the CIBC project on biological control of the potato tuberworm (Lloyd, 1972). Additional species (eight insects and one nematode), reported as parasites of the potato tuberworm in South America (Table 1), were not collected.

Of the ten parasites received from CIBC and released in southern California, only *Copidosoma koehleri* (Blanchard) and *Orgilus lepidus* Muesebeck were established (Oatman & Platner, 1974). Results of general surveys for parasites of the potato tuberworm in 1963 and 1964 and selective surveys in 1968 and 1969 showed that 17 primary parasites are present in southern California (Table 1), at least 15 being indigenous. *Copidosoma koehleri* was not recovered in the 1968-69 surveys and, thus, may have failed to survive.

Parasites of the potato tuberworm, collected in Mexico (ca. 100 miles north of Mexico City), were the same species as those in southern California. Of the seven parasites collected in Costa Rica (near Cartago), only one ichneumonid and two eulophids were in genera different from those collected in California (Table 1).

TABLE 1. Parasites reared from *Phthorimaea operculella* on potato.

Parasite	Collected in
Braconidae:	
Agathis gibbosa (Say)	California
****Agathis tandilensis* Blanchard	Argentina
***Agathis unicolor* (Schrottky)	Argentina
Apanteles dignus Muesebeck	California
Apanteles scutellaris Muesebeck	California, Mexico
***Apanteles subandinus* Blanchard	Argentina, Peru
***Apanteles* spp. (2)[a]	Peru
****Bracon cuyanus* Blanchard	Argentina
Bracon gelechiae Ashmead	California
***Chelonus curvimaculatus* Cameron	S. Africa
Chelonus kellieae Marsh	Costa Rica
Chelonus phthorimaeae Gahan	California, Mexico
***Microplitis minuralis* Muesebeck	Uruguay
Orgilus jennieae Marsh	Costa Rica
Orgilus lateralis (Cresson)	California
***Orgilus lepidus* Muesebeck	California, Argentina
***Orgilus parcus* Turner	S. Africa
Orgilus spp.	California, Costa Rica
****Rogas* spp.	S. America
Ichneumonidae:	
***Campoplex haywardi* Blanchard	Argentina, Uruguay
Campoplex phthorimaeae (Cushman)	California, Mexico
Diadegma blackburni (Cameron)	California, Hawaii
Diadegma compressus (Cresson)	California
***Diadegma stellenboschense* (Cameron)	S. Africa
Diadegma sp.	California
Nepiera fuscifemora (Graf)	California
***Nythobia* spp. (2)[a]	Cyprus, India
Pristomerus spinator (F.)	California
***Temelucha* spp.	California, Argentina, Costa Rica
Trathala sp.	Costa Rica
Encyrtidae:	
****Apsilophrys oeceticola* (DeSantis)	Peru
***Copidosoma koehleri* (Blanchard)	Argentina, Brazil, Chile, Peru
Eulophidae:	
Elachertus sp.	Costa Rica
Hyssopus sp.	Costa Rica
***Rhetisympiesis phthorimaeae* Blanchard	Argentina, Peru
Sympiesis stigmatipennis Girault	California

[a]Two species.

*Received in quarantine (1963-1967), Department of Biological Control, University of California, Riverside, from Commonwealth Institute of Biological Control (CIBC).

**Reported as parasites of *Phthorimaea operculella* in South America by CIBC.

TABLE 1. Parasites reared from *Phthorimaea operculella* on potato. *(Continued)*

Parasite	Collected in
Pteromalidae:	
***Lophocomodia* sp.	Argentina, Peru
Scelionidae:	
***Telenomus* sp.	S. America
Trichogrammatidae:	
Trichogramma pretiosum Riley	California
Tachinidae:	
***Incamyia cuzcensis* Townsend	Peru
Mermithidae:	
***Hexamermis* sp.	Argentina

**Reported as parasites of *Phthorimaea operculella* in South America by CIBC.

TABLE 2. Parasites reared from *Keiferia lycopersicella* on tomato.

Parasite	Collected in[a]
Braconidae:	
Agathis sp.	TX
Apanteles dignus Muesebeck	AZ, CA, HI, TX, EL SALV., GUAT., HOND., MEX.
Apanteles scutellaris Muesebeck	CA, HI, TX, MEX.
Bracon gelechiae Ashmead	CA
Bracon spp.	TX, GUAT., MEX.
Chelonus blackburni Cameron	HI
Chelonus phthorimaeae Gahan	AZ, CA, TX, GUAT., MEX.
Orgilus spp.	CA, TX, GUAT., MEX.
Parahormius pallidipes (Ashmead)	AZ, CA, TX, GUAT., MEX.
Ichneumonidae:	
Campoplex phthorimaeae (Cushman)	CA
**Campoplex* n. sp.	TX, MEX.
Pristomerus hawaiiensis Perkins	HI
Pristomerus spinator (F.)	HI, TX, GUAT., MEX.
Trathala flavoorbitalis Cameron	HI
Eulophidae:	
**Elasmus nigripes* Howard	TX, GUAT., HOND., MEX.
Sympiesis stigmatipennis Girault	CA
Pteromalidae:	
**Zatropis* sp. (near *Tortricidis*)	GUAT.
Bethylidae:	
Goniozus sp. (near *Platynotae*)	CA, GUAT.
Trichogrammatidae:	
Trichogramma pretiosum Riley	CA

[a]AZ = Arizona; CA = California; HI = Hawaii; TX = Texas; EL SALV. = El Salvador; GUAT. = Guatemala; HOND. = Honduras; MEX. = Mexico.
*Species collected by Burkhart that differed from those collected by Oatman.

The parasite complexes in North and South America are similar (Table 1), suggesting the existence of ecological homologues on the two continents. As noted by Lloyd (1972), parasites occurring most commonly in each continent include one egg-larval parasite each, two gregarious external larval parasites each, six solitary, internal larval parasites (Braconidae) each, and three solitary, internal larval parasites (Ichneumonidae) each. The biologies of most of these have been published (Leon & Oatman, 1968; Oatman et al., 1969; Djamin, 1970; Cardona & Oatman, 1971; Odebiyi & Oatman, 1972; Oatman & Platner, 1974; Cardona & Oatman, 1975; Odebiyi & Oatman, 1977; Flanders & Oatman, 1982; Teran, 1983; Powers & Oatman, 1985).

Twenty-one species of primary parasites of the tomato pinworm have been recorded (Table 2). Ten of these have been recorded from southern California, nine each from Guatemala, Mexico and Texas, and six from Hawaii. Of the ten parasites recorded from southern California, six are common (Oatman, 1970; Oatman et al., 1979). Overall, *Apanteles dignus* Muesebeck is the predominant parasite, having been found in all areas surveyed. Except for those from Hawaii, all the parasites (Table 2) occur naturally in the area(s) from which they were collected. Based on the results of foreign exploration trips and personal observations, the tomato pinworm does not occur in Costa Rica, Argentina, or Colombia. The available evidence strongly indicates that the tomato pinworm originated in the area that is now Mexico and Guatemala. The large numbers of parasites (Table 2) associated with this pest species support this. Also, the tomato (principal host) is thought to have originated somewhere in Central America. The higher number of parasites in southern California probably is due to the more extensive studies conducted there (Oatman, 1970; Oatman et al., 1979). The greatest number of different primary parasites (seven) collected by Burkhart in 1977 was near Sanarate, Guatemala.

Neither the potato tuberworm nor the tomato pinworm was collected during the senior author's foreign exploration trip to Colombia in 1973. All the gelechiids collected from both potato and tomato in the commercial-growing areas were *Scrobipalpula absoluta* (Meyrick). In Colombia, this gelechiid mines the leaves of potato, but does not infest the tubers. In tomato, *S. absoluta* mines the leaves and infests the fruit. It is a serious economic pest in that it infests both green and ripe tomatoes, injuring up to 100% of the fruit in spite of repeated applications of insecticides (personal observations). Fifteen parasites were reared from the *S. absoluta*-infested material collected in Colombia in 1973 (Table 3).

While collecting *S. absoluta* near Palmira, Colombia, gelechiid-mined leaves from a native solanaceous weed, *Solanum saponaceum* Dun., also were collected and shipped to Riverside. The gelechiid involved was identified as *Scrobipalpula isoclora* Povolny. In 1975, Mr. Alfredo Saldarriaga, Programma Entomologia, Instituto Colombiano Agropecuario, Palmira, Colombia, shipped additional parasites of *S. isoclora* to us for identification. These species also are listed in Table 3. As both *S. absoluta* and *S. isoclora* are closely related to the potato tuberworm and the tomato pinworm, their parasite

TABLE 3: Parasites reared from *Scrobipalpula absoluta* on potato and tomato in Colombia and from *Scrobipalpula isoclora* on *Solanum saponaceum* in the Cauca Valley, Palmira, Colombia.

S. absoluta	*S. isoclora*
Bethylidae:	
Goniozus nigrifemur (Ashmead)	*Goniozus* sp.
Braconidae:	
Apanteles dignus Muesebeck	*Apanteles epinotae* Vierick
Apanteles gelechiidivorus Marsh	*Apanteles oatmani* Marsh
Apanteles sp.	*Apanteles* sp.
Bracon sp.	*Bracon lucileae* Marsh
	Bracon sp.
	Chelonus (Microchelonus) johni Marsh
	Mirax malcomi Marsh
Chalcididae:	
Invreia sp.	*Brachymeria* sp.[a]
	Spilochalcis hirtifemora (Ashmead)[a]
Eulophidae:	
Elasmus sp.	*Proacrias* sp.
Sympiesis sp.	*Tetrastichus* nr. *chapadae* Ashmead
Tetrastichus sp.	*Tetrastichus* sp.
	Zagrammosoma spp.
Eupelmidae:	
Anastatus sp.	
Ichneumonidae:	
Diadegma sp.	*Pristomerus* spp.
Pristomerus sp.	
Temelucha sp.	
Perilampidae:	
	Perilampus sp.[a]
Pteromalidae:	
	Zatropus sp.
Trichogrammatidae:	
Trichogramma pretiosum Riley	
Tachinidae:	
Elfia (= Plectops) sp.	

[a]Probably hyperparasites.

complexes should be considered in planning an introduction program for biological control of the last two pests. Altogether, about fifteen primary parasites were reared from each of *S. absoluta* and *S. isoclora* (Table 3). The *Apanteles* sp., *Bracon* sp., *Goniozus* sp., *Tetrastichus* sp., and *Pristomerus* sp. listed probably are the same species on both gelechiids. Nevertheless, about 25 different primary parasites were recorded altogether.

Lloyd (1972) stated that "there is good evidence for the claim that the cultivated potato originated in South America and it is a reasonable presumption that the tuber moth also spread over the world from that same general area." Such a statement helps little in delineating the pest's area of origin, considering the size of the land area (continent). Based on personal observations, the potato tuberworm does not occur in Colombia (at least not in 1973), but is present in Venezuela, where it is a pest on tomato near Barquisimeto. Its absence from Colombia is difficult to understand if, in fact, it originated in South America.

Thus, it is equally reasonable to presume that the potato tuberworm originated in North America, as both the pest and its principal hosts, both wild (e.g., *Datura* spp.) and cultivated, commonly occur here (personal observations). Lloyd (1972) noted that several early workers, concerned with the potato tuberworm, felt that the pest originated in North America. The large parasite complex associated with the potato tuberworm in southern California, and the occurrence of the same parasite species in south-central Mexico, suggest that the pest has been here equally as long as it has been in South America. Certainly, those interested in collecting parasites of the potato tuberworm would do well to concentrate their search in the drier, subtropical areas of North America.

ACKNOWLEDGMENTS

Thanks are extended to B. D. Burks, R. W. Carlson, P. M. Marsh, A. S. Menke, C. F. W. Muesebeck, C. W. Sabrosky and L. M. Walkley, Systematic Entomology Laboratory, Insect Identification and Beneficial Insect Introduction Institute (IIBIII), USDA, Beltsville, Maryland, and G. Gordh and J. D. Pinto, Division of Biological Control, University of California, Riverside, for identifying the parasites, and to R. W. Hodges and D. M. Weisman, Systematic Entomology Laboratory, IIBIII, for identifying the Gelechiidae. We also thank Po-Yung Lai, Division of Plant Industry, Department of Agriculture, State of Hawaii, for permission to include parasites of the tomato pinworm, collected by R. Burkhart, and to A. Saldarriaga, Programma Entomologia, Instituto Colombiano Agropecuario, for collecting additional parasites of *Scrobipalpula isoclora*.

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